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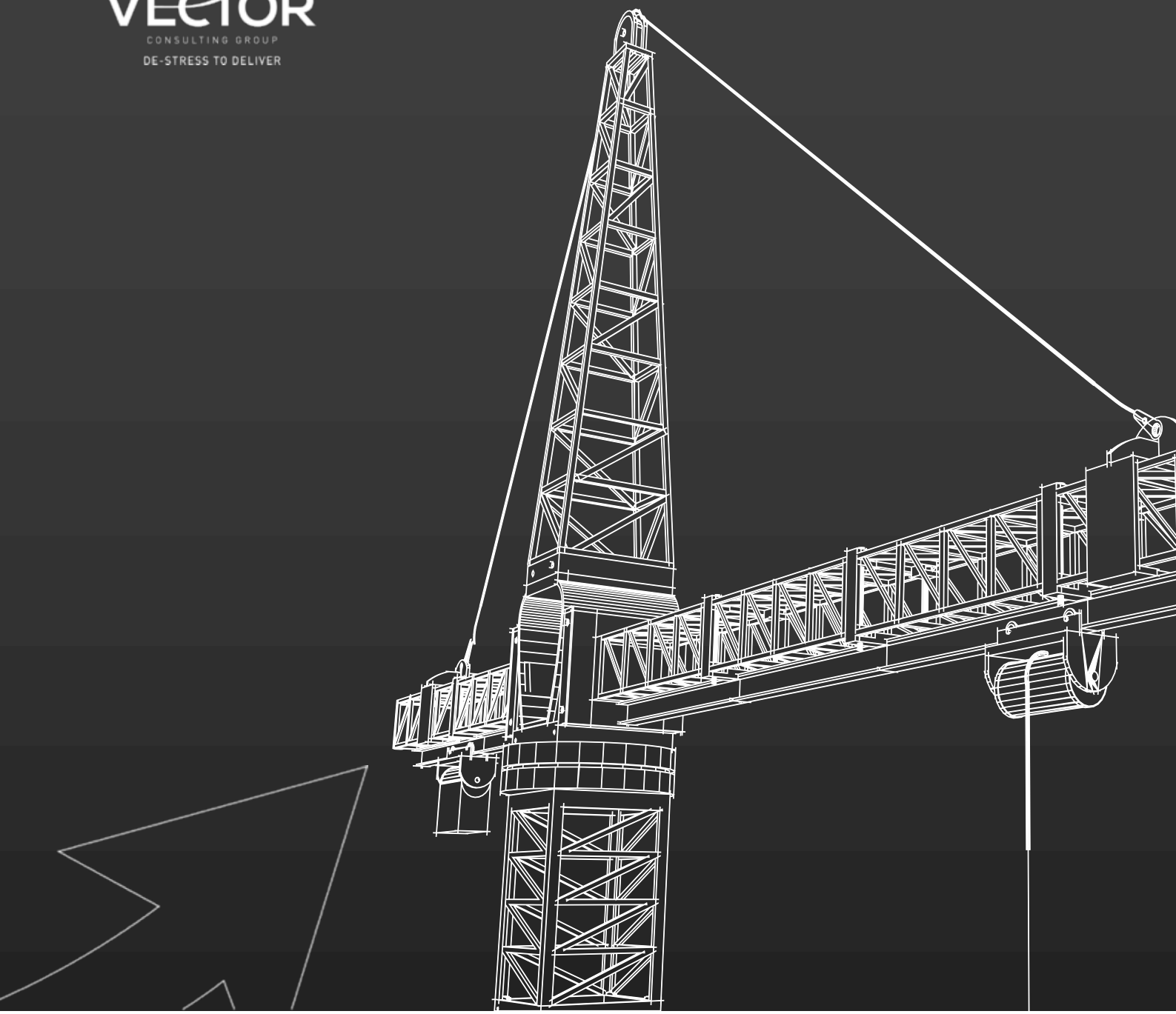

Managing Large CAPEX Projects

Moving away from ‘Project Management’ to ‘Project Flow Management’

By **Abhishek Singh**, **Satyashri Mohanty** and **Anantha Keerthi**

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1 | Introduction

The Vice President of a Rs. 5000 Crs. chemicals company, heading the project management department, had a debilitating feeling about the way the key project in his portfolio was progressing. The Rs. 4500 Cr. CAPEX project was one of the most ambitious projects ever undertaken by the company. While the project reports claimed that it was 78% completed, the VP was not sure if the remaining 22% of the project would finish in the next six months, his promise to the board.

The project was getting into the commissioning phase, and the ground reality seemed very chaotic to him. He was facing daily conflicts in priority for usage of cranes and space, between equipment erection team, electrical, structural and the piping teams. Every team complained of not getting a clear work front from the others. To solve the problem, the VP had made a detailed plan to synchronize all activities but there was slippage even on the latest plan. The review meetings did not help either, as blaming and disharmony were the only outcome. The VP was not sure what he would communicate to the board!

The above storyline is not an isolated anecdote of a failed project. Research on performance of industrial CAPEX projects suggests that as many as seven out of 10 major industrial, energy, petro-chemical and process related CAPEX projects fail to meet their planned cost and schedule goals. This is alarming because India is expected to invest about 4.08 trillion INR in FY22 in industrial CAPEX, and that is expected to grow by 11.7% in FY23. If past track record is the indicator of future, a majority of the projects will be delayed significantly and will run into budget overruns. This will not only be a financial burden to the individual firms but also a risk for the financial institutions backing the projects.

2 | Deciphering the Wicked Problem

Delays and Overruns in CAPEX Projects

Fuzzy Front End and Irrational Exuberance

Many manufacturing firms in India avoid complete turnkey projects for saving on projects costs. Therefore, they end up hiring, coordinating, and managing multiple independent vendors, contractors and equipment suppliers. This model, as opposed to a third-party turnkey contract, provides the manufacturing firm with flexibility to set up aggressive deadlines, without seemingly having any commercial implications of formal liquidated damage (LD) clauses, which a turnkey contractor may have to sign-off for acquiring the project. Hence it is not unusual for such firms to always set targets to complete projects in record time and costs, while initiating the project. Irrational exuberance does not cost any money! The assumption being, more aggressive the timeline, lesser would be the execution lead time!

So, plans are created with ambitious targets. At this initial stage it is assumed that these targets can be achieved because, without detailed designs, there is limited knowledge of details and potential schedule constraints. All CAPEX projects start with a fuzzy front end. The only information available is the volume of work of functional tasks.

Once the project plan is made, and the elapsed durations for respective agencies are arrived at, the individual agencies/ functions are expected to commit to these durations that subsequently forms the governing mechanism for managing the project stakeholders during the lifecycle of the project.

Contracts do have overall durations, but they mostly lack details of inter-agency handovers and clear completion criteria. So, the real focus of the contract is payment terms linked to gross volumetric scope of work completed – cubic meters of concrete for civil contractors, metric tons of structure/ equipment erected/fabricated for structure and equipment erection contractors respectively, inch – meters of piping for piping contractors, running meters of cabling/ cable tray for electrical and such.

The point to ponder is that the plan that forms the controlling tool for firms managing projects in such multi-agency setups is built on very little understanding of the project's uncertainties and schedule constraints.

Listed below are a few examples of such uncertainties and schedule constraints

- The civil contractor does not know if the concrete volumes are for mass pouring structures (floors, foundations) slabs, walls or high-rise structures.
- The structure erection agencies know the tonnages, but not the count of lifts, available space for crane placement, material storage yard's location and access routes to erection locations.
- The equipment erection contractors understand the equipment tonnage, but not the number of child parts in each equipment, the state of the equipment upon delivery - assembled/ dis-assembled, EOT availability, or assembly space availability on the shop floor.
- The commissioning agencies do not know the number and type (process speed, process time, product/ process output quality, safety of operation) of defects, and the number of iterations required to fix the defects.
- While having an idea of total tonnage, structural fabrication agencies will not be aware of the split of building and technological structures, availability and closeness of fabrication and painting yards, and ODC requirements in logistics.

3 | The Core Problem

Non-acceptance of Inherent Nature of CAPEX Projects

Information that impacts the accuracy of time estimates surface progressively in any CAPEX project as designs get over, the various stakeholders come on board and the size of resource teams become clear. The point to understand here is that task durations are a function of multiple such factors, and not just the volumetric scope of work. **Managing the project through functional commitments to a milestone due date in a plan, created in the absence of these details is the foundation of all troubles at later stages of the project.**

As execution starts in the design team, soon it becomes clear that each agency is focused not on milestone dates on the project plan of the client, but to the agreed duration commitment for their work. This duration commitment is, in fact, conditional on receiving inputs on time.

At this fuzzy front end of the project, when work is just starting and not much money is deployed on the project, the overall top management reviews of project are usually very weak. The resultant impact is bad synchronization between purchase and design agencies. Purchase is focused on getting the best possible price, while design agencies would want to get inputs from key equipment vendors in a specific sequence to complete their designs handover for initiating site work.

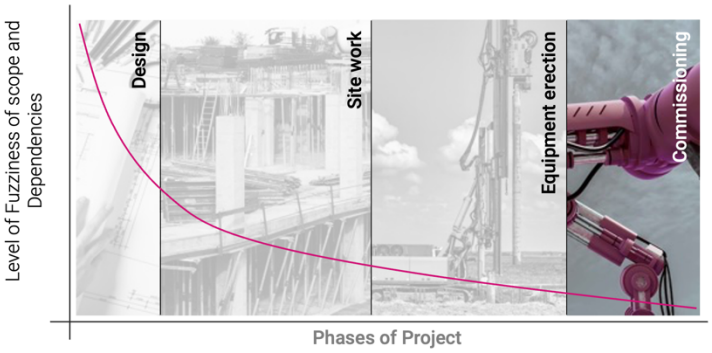

Figure 1: Phases of a project and levels of fuzziness about scope and dependencies

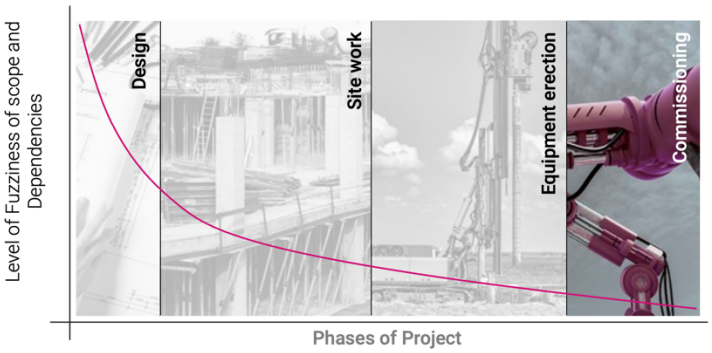

Figure 1: Phases of a project and levels of fuzziness about scope and dependencies

As a result, engineering drawings are released based on assumptions, since vendor inputs are not available in time.

This sets the stage of when the committed “durations” in contracts actually become very “leaky” in execution. Partial handovers become the way to “manage” durations in the contract. This leads to unplanned concurrency in projects that keeps increasing in later part of projects.

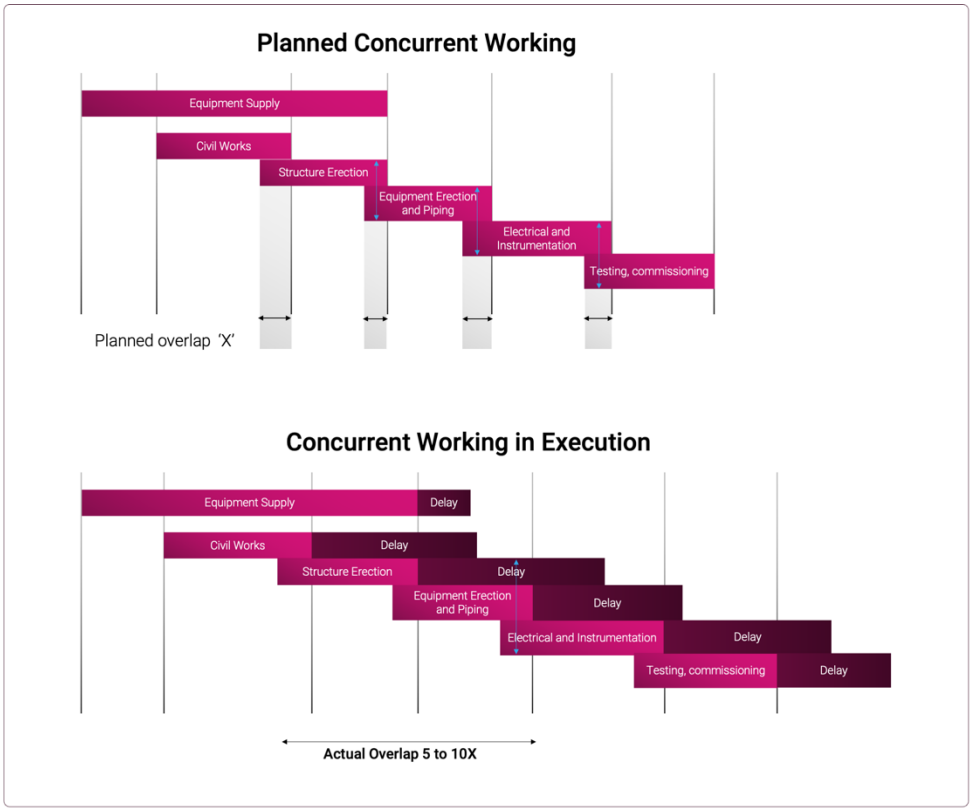

Figure 3: Concurrent working - Planned vs Reality in execution

In the initial phase of execution, the volumetric completion keeps reasonable pace as per contracts. Also, during this phase, volume-based progress always appears good at site, due to the nature of work that involves lesser complexity of coordination, such as civil foundation concreting work at sites. If the bulk of the volume of work is completed by set milestones, it seems as if the project is doing reasonably ok. However, this illusion of good progress camouflages growing handover and interruptions in work issues.

As delays show up on various work-fronts and interruptions affect utilization of contractor manpower, pressure gets built to open more work fronts. This leads to ballooning work-in-progress and thin assignment of resources, in almost every functional group. Many open fronts help contractors maximize the respective contractual metrics for best possible monthly billing, but soon it leads to the following types of de-synch between teams:

- High inventory of non-erectable structure steel/equipment (out of sequence supply)
- High inventory of structural material due to non-availability of required civil work-fronts Multiple buildings with structural columns, beams and girders (high tonnage members) erected, but balance purlins, bracings and brackets stay open
- Piping erected with missing valves and fittings

- Multiple equipment erected with pending alignment, electrical terminations, and piping connections

Eventually projects develop a ballooning plug list of open items and defects - safety, equipment alignment, piping and electrical connections to equipment. The multi-functional nature of problems increases elapsed time of commissioning. The attention paid by the project manager goes up, but at the same time, many agencies dilute their commitments, as their bulk billing has already been done by this stage. This leads to poor predictability for project handover. The real failure in such projects is not just the delay in completion, but a significant time lag (years, in many cases) between start of production and a ramp-up to desired capacity.

4 | The Paradox of Control

Premise of Critical Chain Methodology

Premise of Critical chain methodology of on time performance is with a premise that scope dependencies and resource limitations are well understood right at beginning of the project.

If scope, dependencies and resource constraints are well understood, then the project buffer calculated in the planning phase, is a reasonable protection against variability of task time variations. A practice of good buffer management in execution will ensure on time performance.

But this method which relies on variance from a baseline plan as the control mechanism for execution, will fail to deliver in environments where scope level uncertainty is significant and cannot be pre-identified.

Good control over project execution can be exercised when project plans incorporate complete information, right at the beginning. This will facilitate good handover management between agencies, and hence hold agencies accountable for durations and clear completion of work. However, when the environment is such that knowledge will emerge only when one progresses, project plans do not provide any control on execution.

At best, they just “report” the progress of execution in environments where replanning is done regularly on discovery of new scope or dependencies.

At worst, they can blind the top management from what is happening in execution. This is because in many environments, where managerial commitments are strongly tied up with original plans, resistance builds up in the system against replanning to avoid sharing the ”bad” or the “failure” news. So plans in such environments stay fossilized in an older state, giving bad information to top management, while execution has already changed its gears. So, any methodology, whether it is the critical path method or the critical chain method, which depends on the accuracy of an initial baseline plan to control execution, will fail miserably.

So, what is the solution?

5 | A Radical New Approach

Flow Management for Project (FMP)

If we cannot use variation from a baseline as an approach to control execution, the only way left is to find different ways of controlling wastages of time, in changing ground conditions of execution. This implies that one has to achieve the following conditions in execution:

- All resource groups synchronize and collaborate towards completion
  - Minimal inventory of "unwanted" tasks of future, while maximizing speed of "wanted" tasks of current execution priority
- Handovers are complete and clean between agencies
  (no conflicts between resource groups for clear front availability)
- Resources are adequate for high priority tasks.
- There is a state of flow of tasks while executing work fronts. There is minimal or near zero waiting time for missing items when work is already initiated

If one achieves the above conditions in execution, the project will be completed in the shortest lead time, regardless of the accuracy of an "original schedule". This can done if five golden execution principles (which do not depend on schedule perfection) can be followed:

5.1 Limits on Work in Progress

Principle: If constraint resource cannot be known upfront, it is better to know how to prevent the damages when they emerge in execution.

For this, it is important to limit the WIP of "work bundles" based on resource availability within different functional resource groups right from design to civil or structural erection and equipment erection phase

- The WIP rules are set based on rule of optimal assignment of resources. (One is allowed to open as many work fronts as one can do full resourcing.)
- The WIP rule implementation implies that every stakeholder shares the information of quantum of resource deployment for the defined work bundles.
- This rule also implies that the work bundles are clearly and progressively defined as the project moves into various phases.
- The entry and exit criteria of work bundles are followed strictly to ensure a clear handover of work bundles between resource groups. New work is allowed to be opened only when the one in the stipulated WIP is over.
- WIP rules clearly expose the queuing and resource constraints in different functional groups.

5.2 Sequential Number Priorities

Principle: Task schedules will always be delayed; they cannot provide clear stable priorities, and the above WIP control rules require clear priority of what needs to be done next.

For stable priorities, it is important to provide clear sequence of initiating the work bundles in terms of an easy-to-understand number-based token system.

This implies that the project has to be perpetually replanned as per the latest understanding of the status of execution. This will help identify the latest longest path and slacks available on feeder paths for setting the token-based priority numbers.

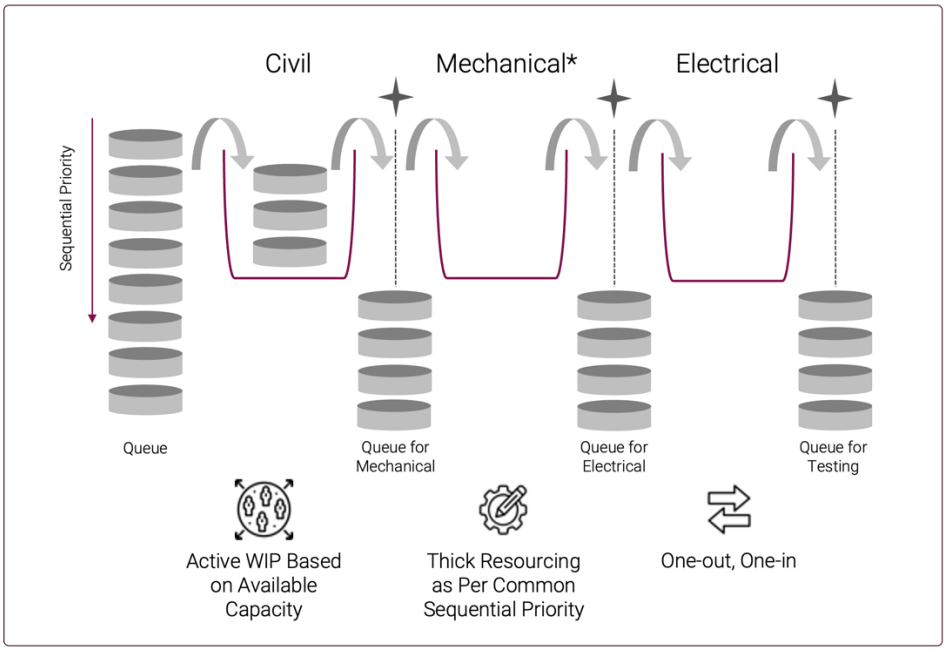

Figure 4: WIP Control with Sequential Priority system in Engineering

5.3 Work with Full Kits of Defined Work Bundles

Principle: Work happens fastest when complete inputs required to start and complete the task are available even before the initiation of the tasks.

For each function to complete work in the minimum possible time before handing-over, the full-kit - materials, resources, approvals, tools, supervision capacity – required to complete the task must be arranged in full before starting the task.

- The team required to ensure the full kit should be different from those executing the work bundles.
- The key performance measure of the full kit team is to ensure adequate bank days of work for the respective execution teams.

The waiting, queuing and clear priorities enable one to create a bank of full kits.

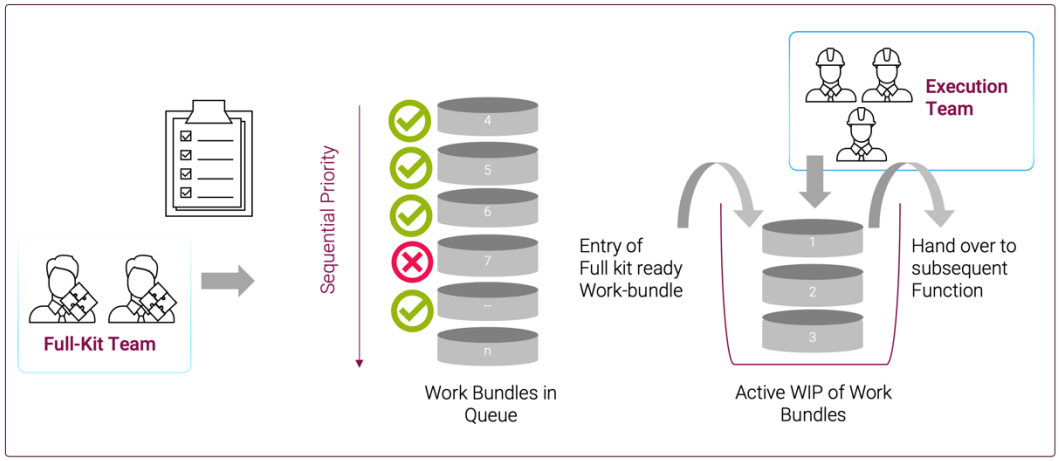

Figure 5: Working with Full-kits of Defined Work Bundles

5.4 High Frequency Management

Principle: If deadlines are going to be missed, the only way one can control task durations from expanding is by controlling elapsed time by evaluating progress and resolving issues in a cadence set at very high frequency.

For each function to complete work in the minimum possible time before handing-over, the full-kit - materials, resources, approvals, tools, supervision capacity – required to complete the task must be arranged in full before starting the task.

A daily cadence of cross-functional stand-up meetings in projects, along with weekly cadence of top management review will help agencies synchronize on priority issues and provide timely resolution.

5.5 Contract Flexibility

Principle: Contract terms should facilitate right behavior for overall completions of project at every stage of execution.

Payment terms should incentivize contractors to ensure faster and clean handover of work-fronts to downstream contractors, while providing flexibility to add resources without losing margins when required. This will help manage queues exposed by the WIP control rules.

The above five principles are part of a new management method called Flow Management in Projects. It requires supporting dashboards that focus on providing rate of work bundle completions in different resource groups, while dynamically calculating the expected completion date of projects based on daily inputs of work completion and queues in the system. Companies also need to streamline information systems to clearly tag the work bundle identification in designs, purchase orders and vendor MIS to help understand completion details as per work bundles.

The resultant impact is much better predictability, visibility on issues, and hence a stronger control in projects.

6 | The Final Verdict

Does the implementation of the above flow management rules guarantee completions on time, as per original estimates?

Since the new system does not depend on the level of scope accuracy of initial plans, it is important to define a new success criterion of a well-managed project. They should have the following outcomes:

- Even if the project is delayed as per a super aggressive original plan, the total execution lead time is amongst the rare shortest ones in the industry, for similar projects executed in the past.
- The closure of the project is very clean without teething ramp-up issues or an ever open "plug" list.
- The ramp-up lead time is also amongst the shortest as per past records of similar projects.
- The project has very high predictability of closure date towards the last phase of the project and does not suffer from the problem of bad predictability. This is because well executed projects have clean closures of work fronts, with only a few remaining on the longest path, while others are completed ahead of time.
- Companies following the FMP model will never face the helpless situation of being totally out of control such as the VP of the chemical company.

1

Limits on Work-In-Progress (WIP)

2

Sequential Number Priorities

3

Work with Full-Kits of Defined Work Bundles

4

High Frequency Management

5

Contract Flexibility

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